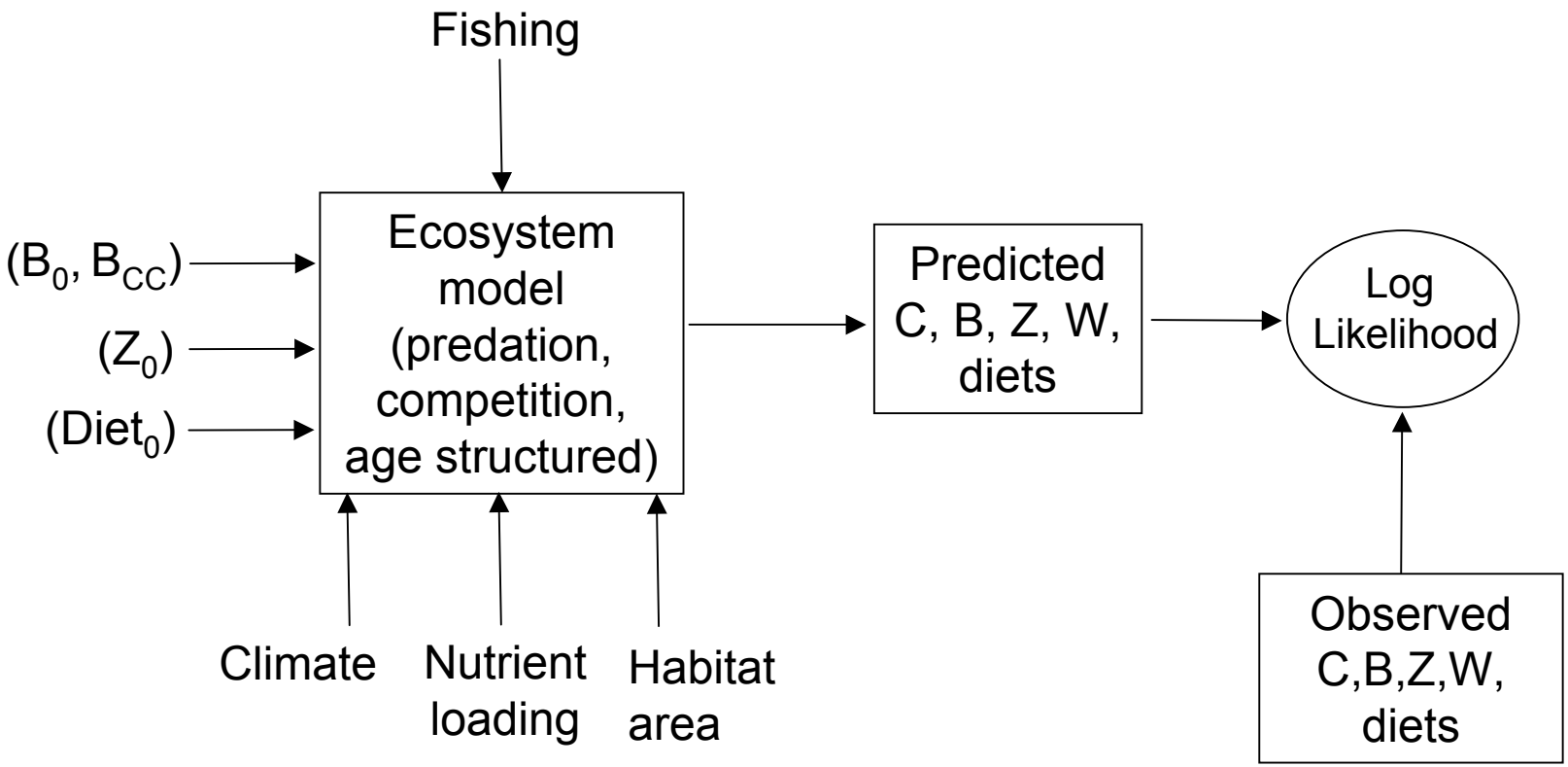
Functional relationships & decision tools for EAF:

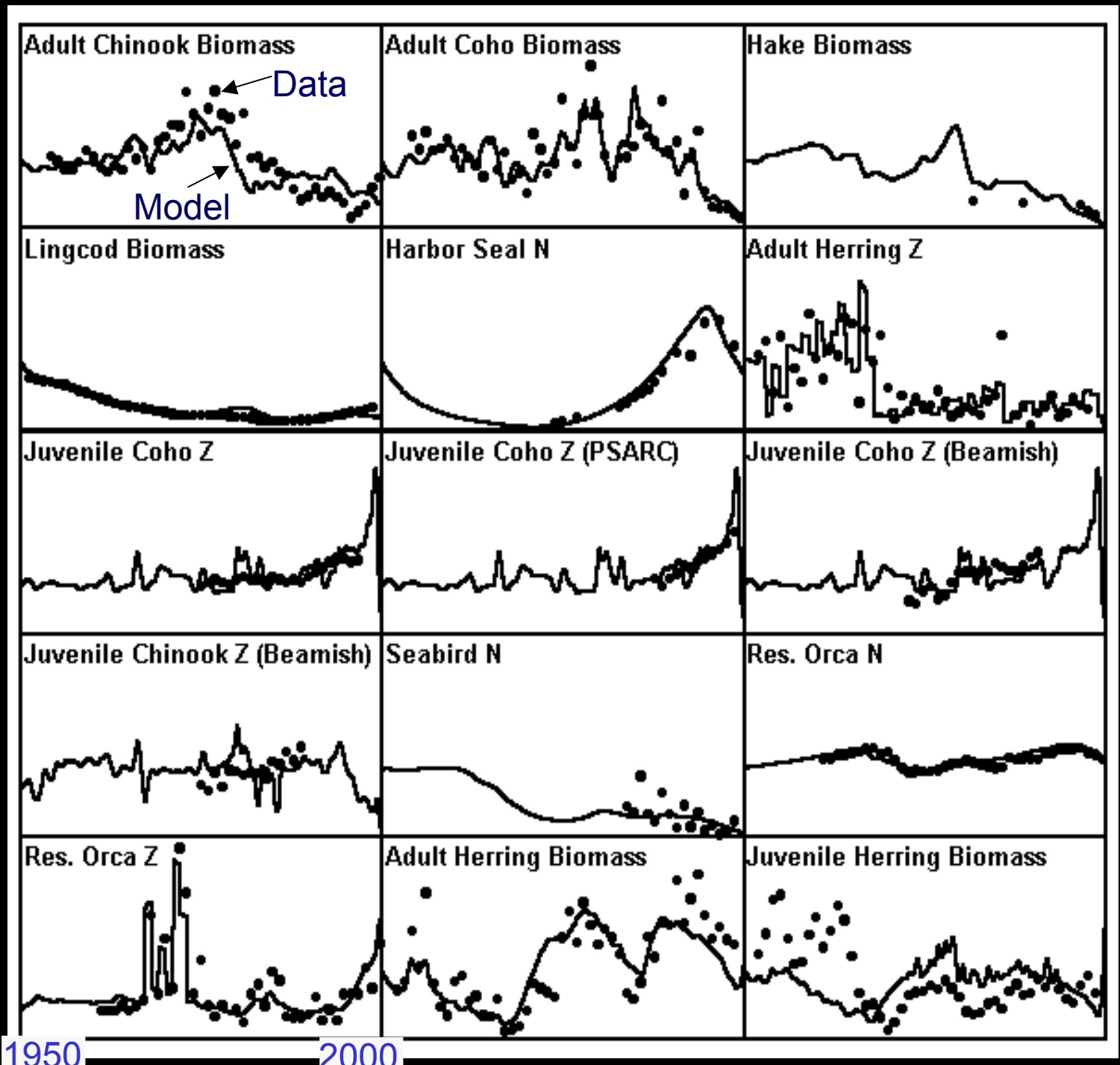
Evaluating environmental, ecosystem, and anthropogenic impact

Villy Christensen, UBC

Modeling process



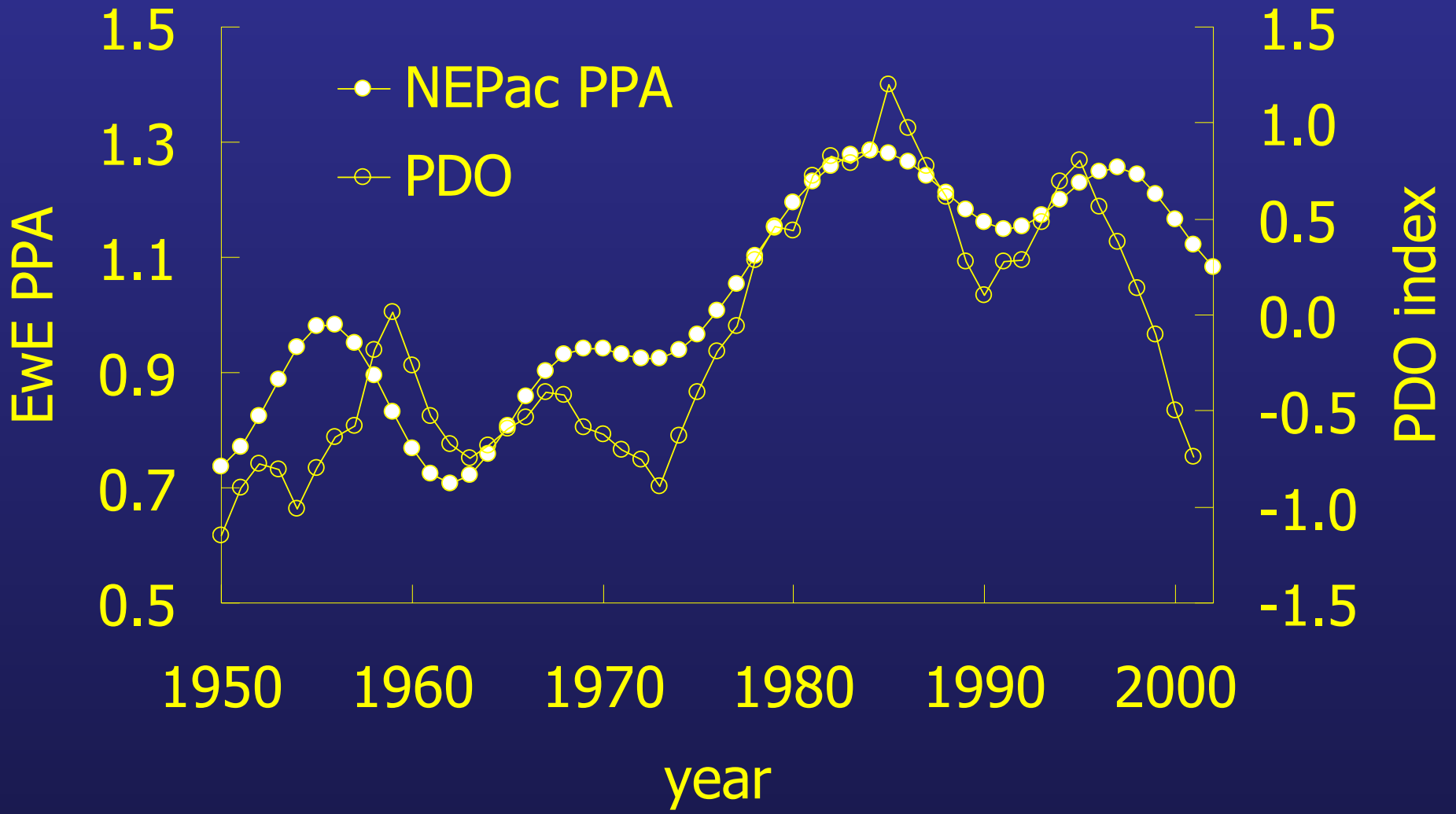
Strait of Georgia time series from assessments or surveys (dots) compared to Ecosim (line)



Ecosystems where models have been tested using historical trend data

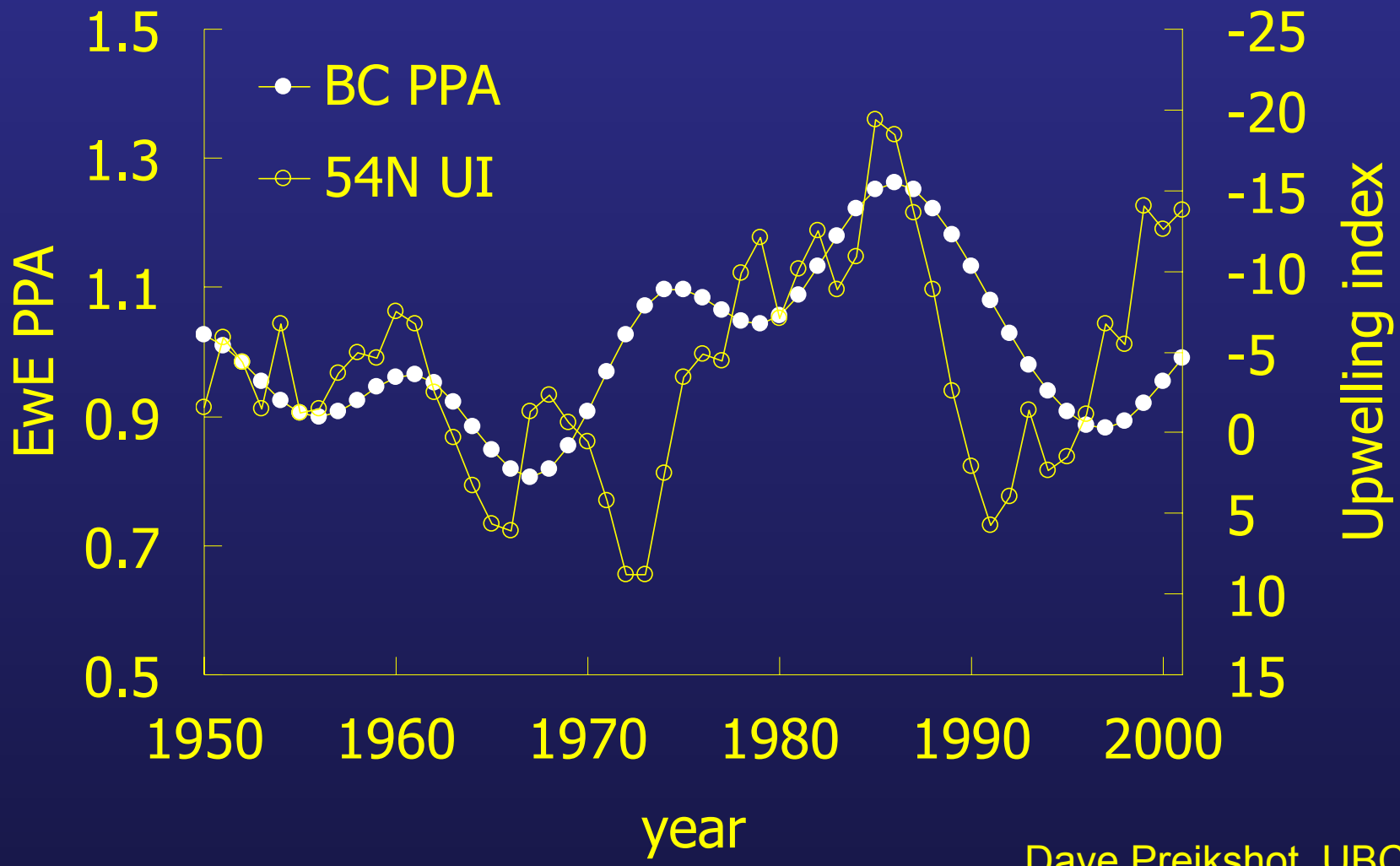
- E Bering Sea
- Aleutian Islands
- W&C GoAlaska
- E GoAlaska
- W Vancouver Island
- Hecate Strait
- Strait of Georgia
- NE Pacific
- Central N Pacific
- FF Shoals, Hawaii
- Central Chile
- Bay of Quinte
- Oneida Lake
- Scotian Shelf
- Cheasapeake Bay
- Tampa Bay
- S Brazil Bight
- North Sea
- Baltic
- S Benguela
- Gulf of Thailand

Estimated Primary Production Anomaly from NE Pacific ecosystem model compared to PDO



Dave Preikshot, UBC FC

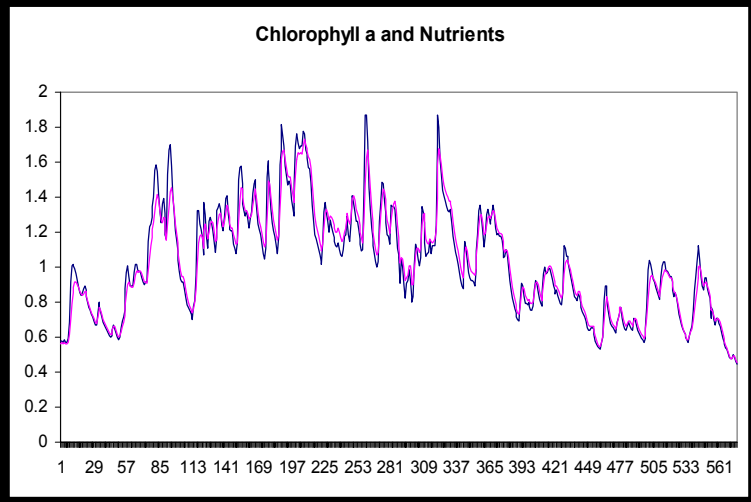
Estimated Primary Production Anomaly from BC shelf ecosystem model & BC upwelling index

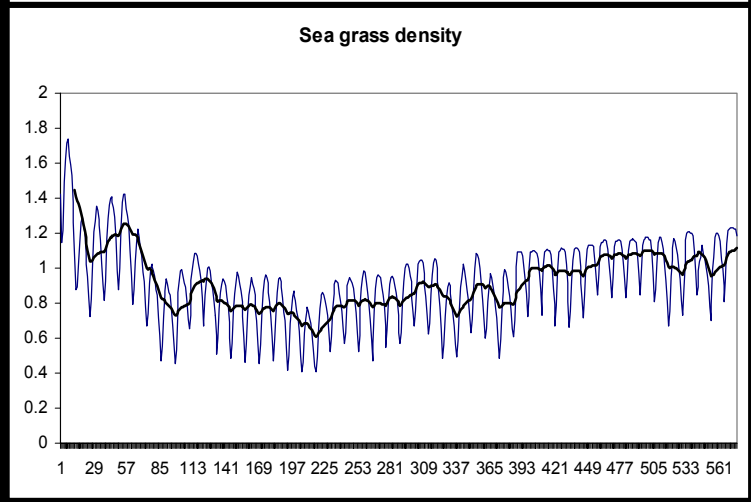


Dave Preikshot, UBC FC

Nutrient loading

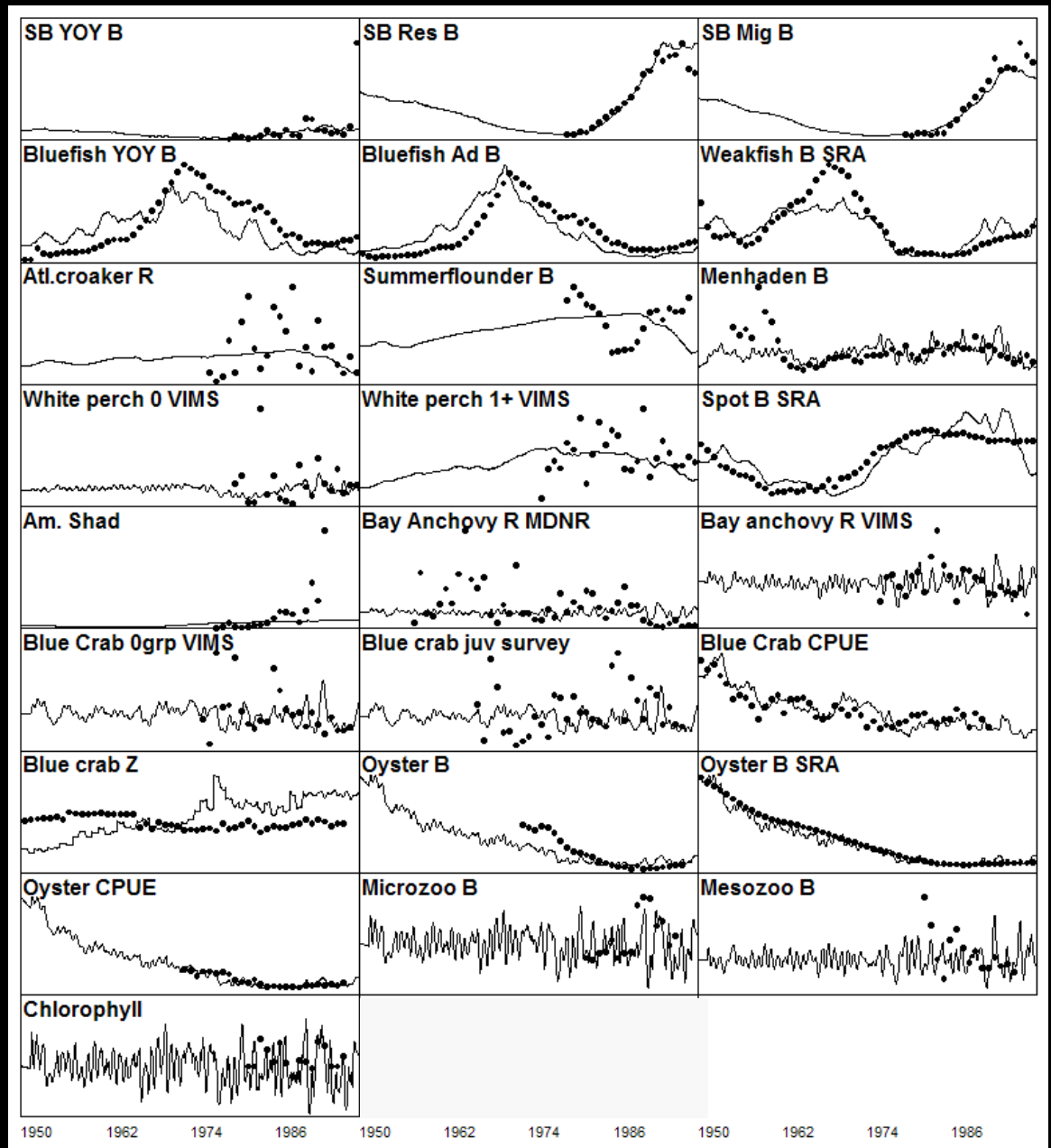
- Florida Bay, Tampa Bay and Chesapeake Bay;
- Monthly wind, rain, river runoff, nutrient loading;
- The derived nutrient loading time series is used to force simulations;
- Sea grass density mediation effects:
  - Chl. a and sea grass;
  - Epiphytes;
  - Habitat area for some fishes, a.o.





Chesapeake Bay

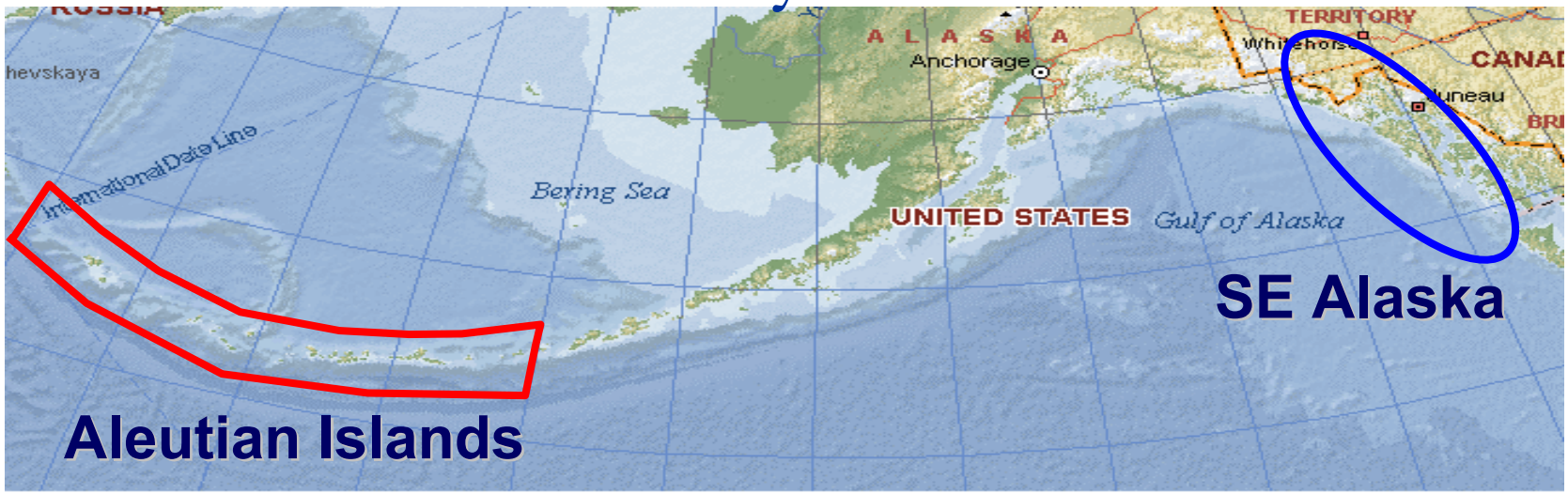
- Ecosystem model is driven with nutrient loading and fishing pressure;
- Model used as 'CB Fisheries Ecosystem Model'
  - Companion to the CB FEP.

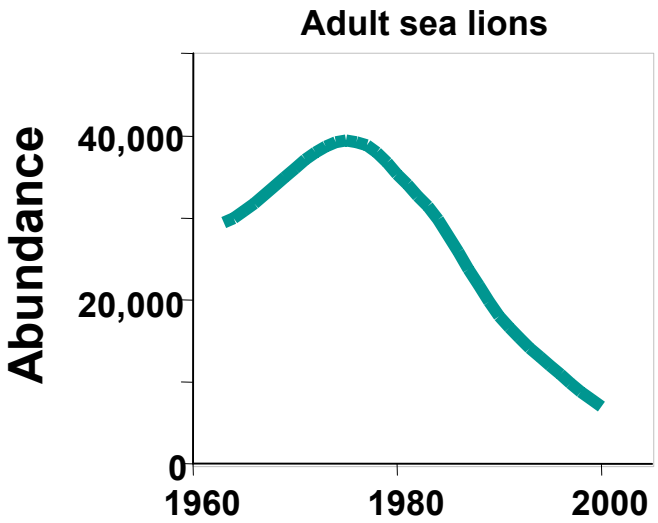


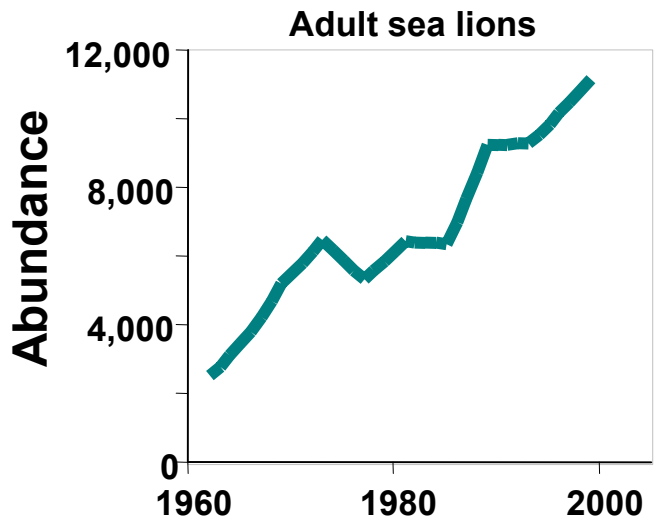
Why have Steller sea lions declined?

Sylvie Guénette
Sheila Heymans
Villy Christensen
Andrew Trites

Two N Pacific ecosystems



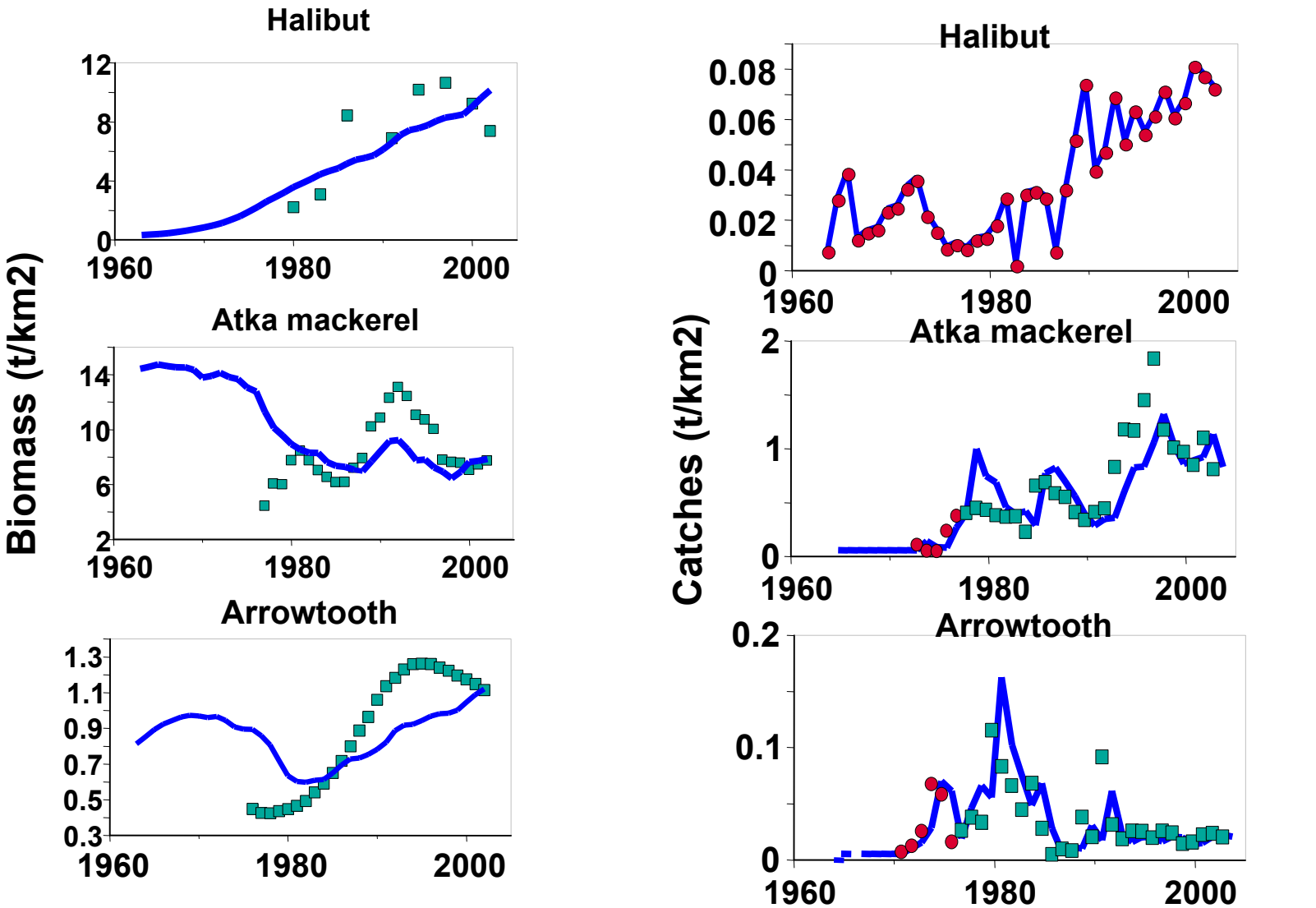




Hypotheses for the SSL decline

1. **Nutritional stress?**
2. **Disturbance?**
3. **Fishing practices?**
4. **Predators?**
5. **Climate?**
6. **Disease?**
7. **Parasites?**

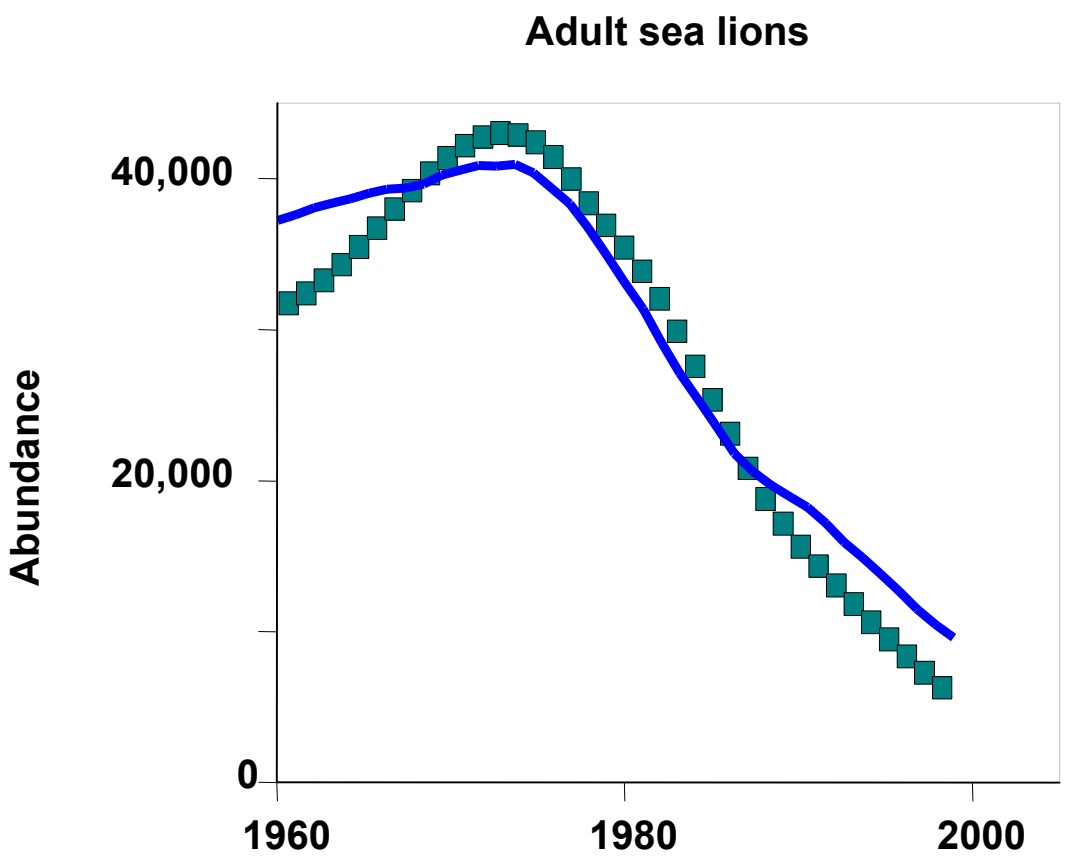
Fitting to time series



Model results, SSL

data
Ecosim prediction

Aleutians

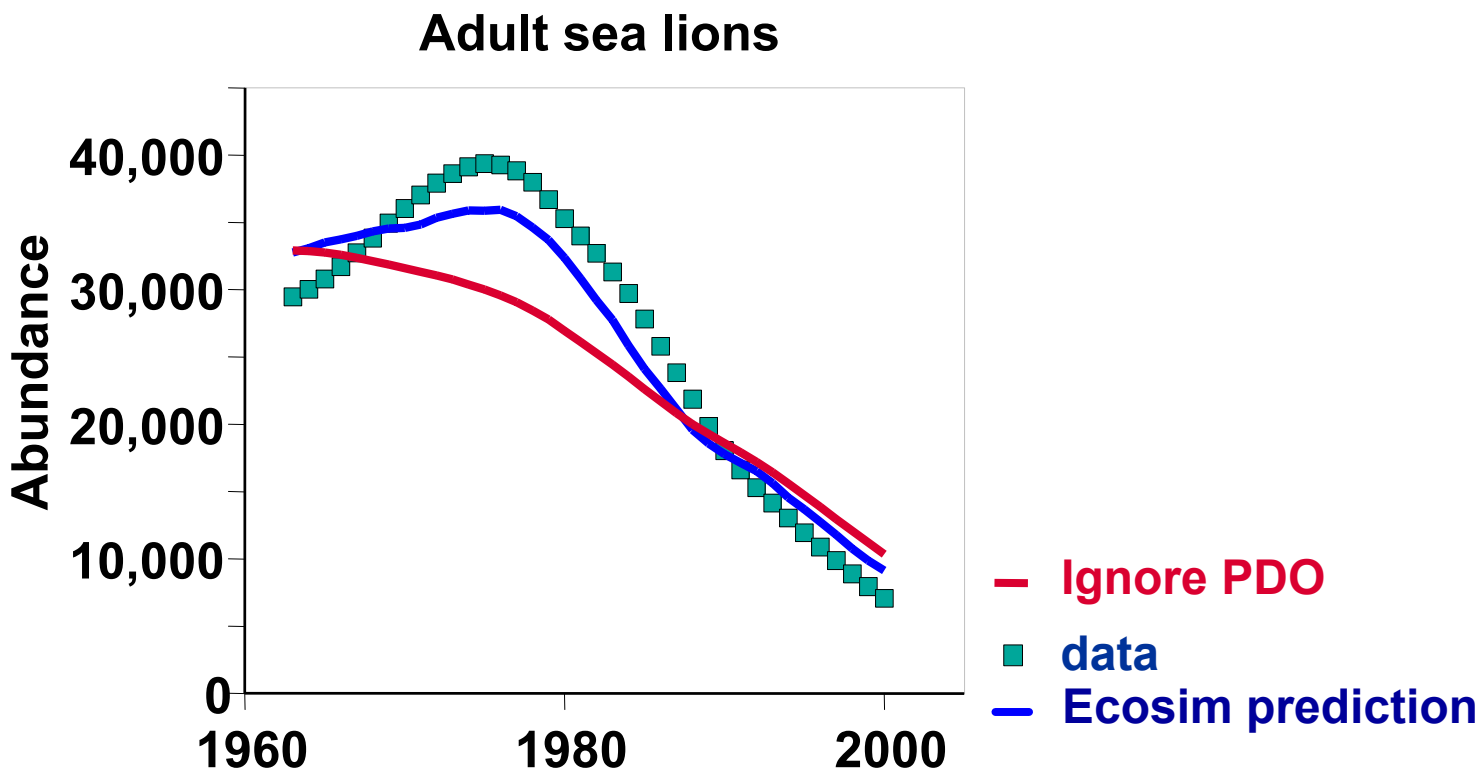


Why does the model reproduce the sea lion dynamics so well?

- We evaluated the relative impact of:
  - Changes in ocean productivity (PDO)
  - Fishing (catches)
  - Predation (orcas)
  - Competition (flatfish)

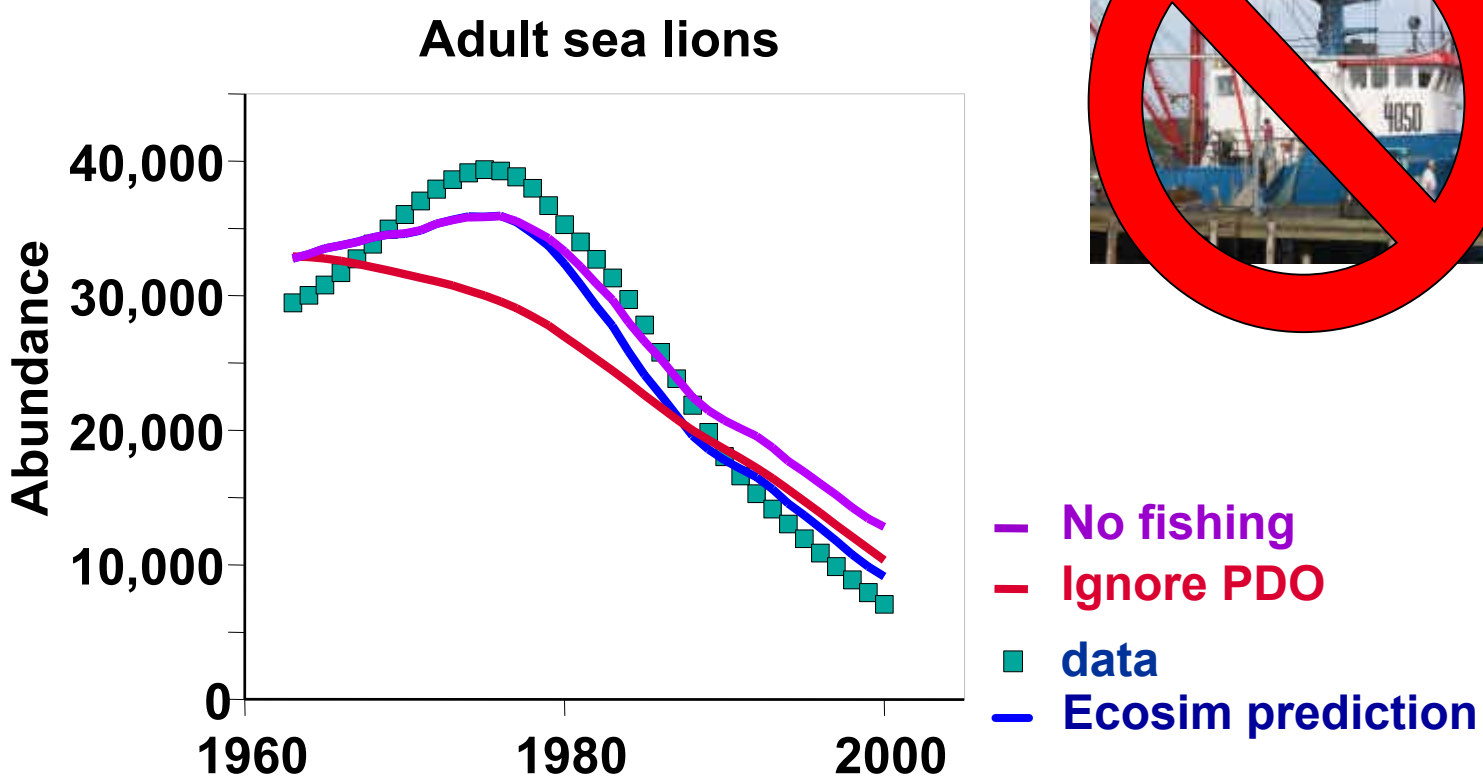
Impact of ocean productivity (PDO)

Aleutians



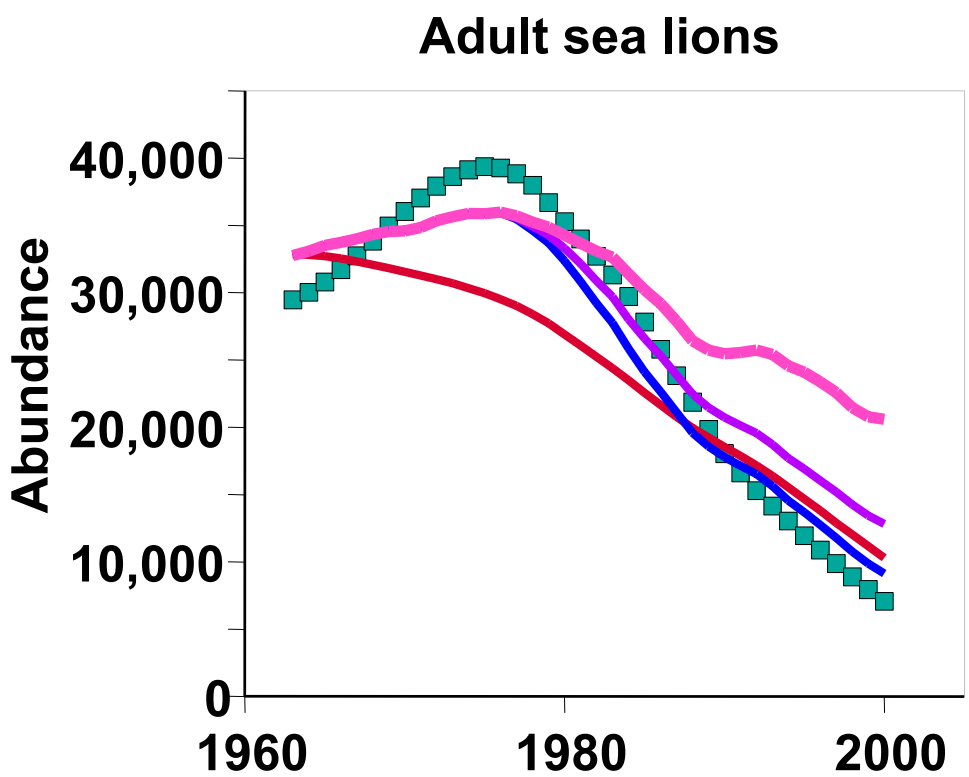
Impact of fishing

Aleutians



Impact of orca predation

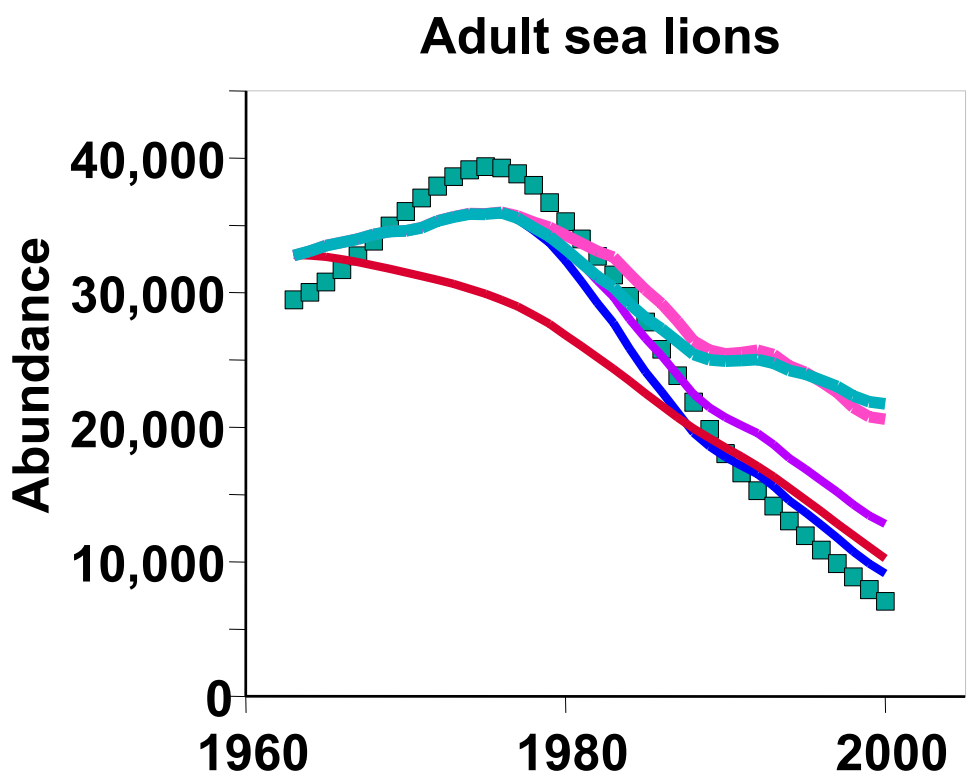
Aleutians



- No predation (orca)
- No fishing
- Ignore PDO
- data
- Ecosim prediction

Impact of competition from flatfish

Aleutians



- No competition
- No predation (orca)
- No fishing
- Ignore PDO
- Ecosim prediction
- data

Model indicates:

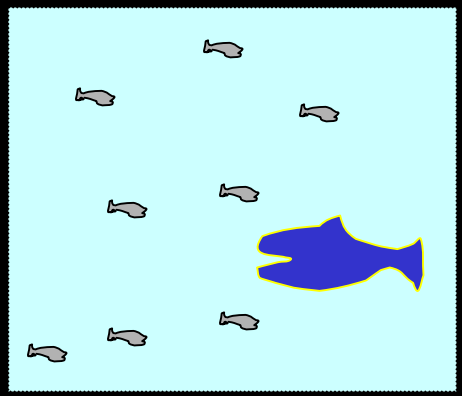
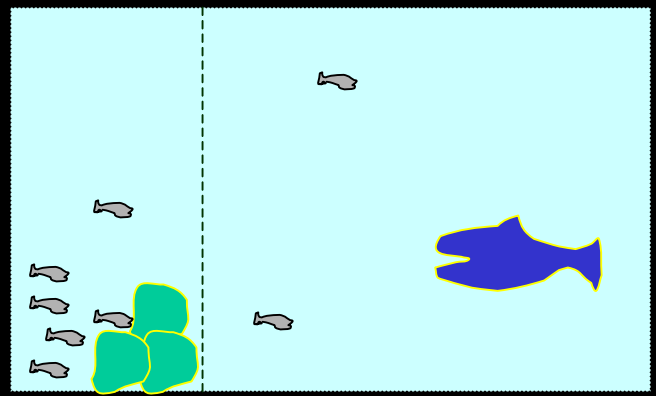
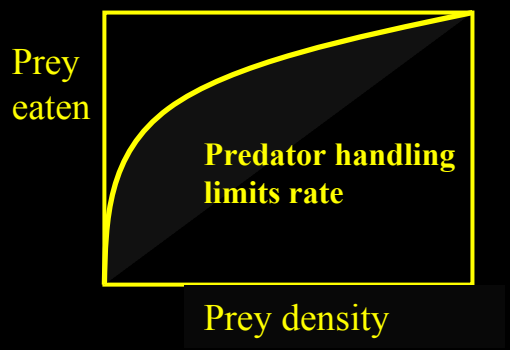
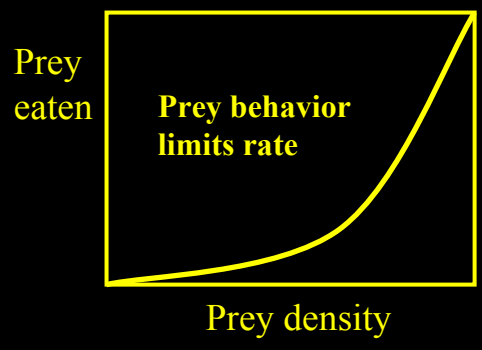
- changes in competition, predation and ocean productivity are required to explain the sea lion decline;
- fishing had the least impact;
  - pollock fisheries is not a major enterprise in the Aleutian Islands.

A key aspect of the modeling:

- Prey behavior limits predation (foraging arena assumptions)

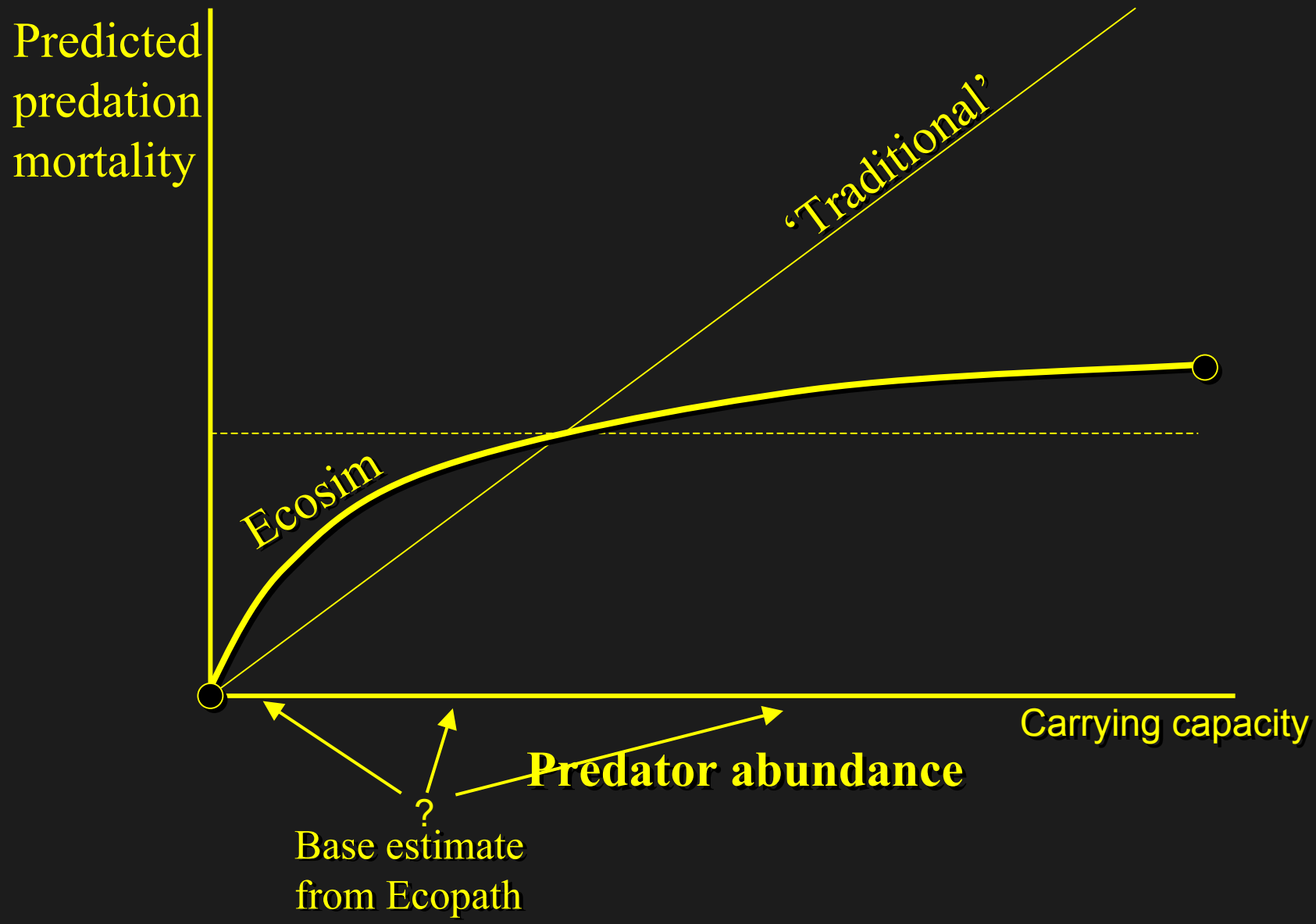
Organisms are not chemicals!

Ecological interactions are highly organized

Reaction vat model	Foraging arena model
	
	

Big effects from small changes in space/time scale

Predation mortality & carrying capacity



Are we finally able to develop useful predictive models for ecosystem management?

- It's beginning to look like it;
- We can with some credibility describe agents of mortality and trophic interdependencies;
- Evaluation of relative impact of fisheries and environmental factors is progressing (at the 'looking for correlation'-stage.)

Experience so far:

- Prim. productivity anomalies may or may not be amplified through the food web;
- Possible to replicate development over time
  - often by incorporating environmental as well as fisheries impact;
- Requires more data
  - but mainly data we should have at hand in any case: ‘the ecosystem history’;
- Supplements single species assessment, does not replace it;

Acknowledgements